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Comparison of Clinical Outcome of Direct Composite Resin Versus Amalgam Restoration in Permanent Posterior Teeth

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ABSTRACT

Background: Composite resins are increasingly preferred over dental amalgam due to their aesthetic appeal, conservative preparation, and biocompatibility. However, the durability and long-term clinical performance of composite restorations in posterior teeth remain a subject of debate. **Objective**: This study aimed to compare the clinical outcomes of direct composite resin versus amalgam restorations in permanent posterior teeth across two dental units at Bolan Medical College, focusing on material preference, longevity, and patient perception. **Methods**: A cross-sectional observational study was conducted with a total of 327 restorations analyzed from patient records and dentist/student surveys. Inclusion criteria encompassed patients requiring direct restorations in molars or premolars, while those with extensive structural loss requiring indirect restorations were excluded. Data collection included patient records and structured questionnaires. Statistical analysis was performed using SPSS v23.0, employing chi-square tests for categorical comparisons ($p<0.05$ considered significant). **Results**: Among 693 posterior restorations, 78.28% were resin-based, while 21.72% were amalgam. The dental department predominantly used composite (92.63%), whereas amalgam was more frequent in public health units ($p=0.000$). Clinical evaluation suggested superior aesthetics and patient preference for composite, but amalgam remained preferred for durability. **Conclusion**: While composite is increasingly favored in academic settings, amalgam remains integral in public health dentistry due to cost-effectiveness and longevity. Findings highlight the need for balancing aesthetics with clinical durability in restorative dentistry.

INTRODUCTION

Dental amalgam has been a cornerstone in restorative dentistry for over a century, owing to its cost-effectiveness, ease of use, and well-documented longevity. Despite its durability and mechanical strength, the demand for alternative materials has surged due to concerns regarding aesthetics, biocompatibility, and the environmental impact of mercury (1,2). Composite resins, introduced as a tooth-colored alternative, have gained widespread acceptance, particularly in posterior restorations, due to their ability to preserve dental tissue through adhesive bonding techniques. The shift towards resin-based restorations aligns with the principles of minimally invasive dentistry, which emphasizes conservation of the tooth structure while achieving optimal functional and aesthetic outcomes (3). However, despite their growing popularity, concerns persist regarding their clinical longevity, wear resistance, and higher technique sensitivity compared to amalgam (4,5).

A key consideration in this transition is the disparity between material choices in public health and private or academic settings. While dental institutions increasingly favor composite restorations, public health systems continue to rely on amalgam, often due to its cost-effectiveness and reduced technique sensitivity, particularly in high-volume patient care settings (6). Furthermore, the clinical training of dental students remains divided, with some institutions phasing out amalgam education entirely, while others maintain its instruction to prepare students for real-world practice (7). This discrepancy raises concerns about whether the clinical performance and survival rates of composite restorations justify their preference over amalgam in posterior teeth, particularly in high-stress occlusal environments (8,9).

Existing literature provides mixed findings on the long-term performance of resin-based restorations in posterior teeth. Some studies suggest that modern composites, when properly placed, exhibit survival rates comparable to amalgam in small-to-moderate Class I and II cavities (10,11). Others indicate that composite restorations are more prone to wear, marginal degradation, and secondary caries, necessitating more frequent replacements over time (12). Additionally, while patient preference and aesthetic concerns drive the demand for composite materials, the choice of restorative material should ideally balance functional longevity, ease of placement, and cost-effectiveness (13).

Given this context, the present study aims to compare the clinical outcomes of direct composite resin versus amalgam restorations in permanent posterior teeth across

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two dental units at Bolan Medical College. By assessing material preference, longevity, and patient satisfaction, this study seeks to address the ongoing debate surrounding the transition from amalgam to composite in posterior restorations. The findings will contribute to evidence-based decision-making regarding restorative material selection in both academic and public health settings. The research question guiding this study is: "Do direct composite resin restorations provide comparable clinical outcomes to dental amalgam in posterior teeth in terms of longevity, patient preference, and practical feasibility?"

MATERIAL AND METHODS

This cross-sectional observational study was conducted at the Dental Department of Bolan Medical College to compare the clinical outcomes of direct composite resin and amalgam restorations in permanent posterior teeth. The study population included patients who underwent direct restorations for carious lesions in molars and premolars. Inclusion criteria encompassed patients aged 18 years and older requiring single or multi-surface restorations without underlying periodontal disease, extensive tooth structural loss, or endodontic involvement. Patients with systemic conditions affecting oral health, those with existing indirect restorations, or those who declined participation were excluded. Ethical approval was obtained from the Institutional Review Board, and informed consent was secured from all participants in accordance with the Helsinki Declaration (14).

Data collection involved a retrospective review of clinical records and a questionnaire-based survey distributed among final-year dental students and practicing dentists. The primary outcomes included the prevalence and distribution of restorative materials, patient preferences, and dentist-reported clinical performance. Secondary outcomes comprised restoration longevity, material selection rationale, and patient-reported satisfaction. Clinical assessment parameters included cavity classification, restorative surface coverage, and material failure rates. A validated questionnaire captured patient perspectives on aesthetics, durability, and overall satisfaction, while dental students and practitioners provided insights into material handling, longevity, and training experiences.

All patient data were anonymized and securely stored to maintain confidentiality. The evaluation process included verification of records for accuracy and completeness. Follow-up data were not included as the study was cross-sectional. To ensure data reliability, records were reviewed by independent assessors. Material selection trends were compared between the two study units, and responses from students and dentists were analyzed to assess the alignment between clinical training and practice.

Statistical analysis was performed using SPSS v27.0. Categorical variables were analyzed using chi-square tests to assess differences in restorative material usage, while descriptive statistics summarized patient demographics, material preferences, and clinical assessments. Missing data were handled through multiple imputation where necessary. Potential confounders such as patient age, cavity size, and operator experience were considered in sensitivity analyses. A p-value of <0.05 was considered statistically significant. These analytical approaches ensured a robust evaluation of the comparative clinical outcomes of composite and amalgam restorations.

RESULTS

A total of 2,357 posterior restorations were analyzed, with 693 performed in the Dental Department and 1,664 in the Public Health Units. Composite resin was the predominant restorative material in the Dental Department, accounting for 78.28% of all restorations, while amalgam constituted 21.72% (Table 1). In contrast, in Public Health Units, composite restorations were significantly more prevalent, representing 92.63% of cases, whereas amalgam restorations accounted for only 7.37% (p=0.000).

When analyzed by tooth type, composite resin was more commonly used in both premolars (85.1%) and molars (74.3%), while amalgam was more frequently applied in molars (25.7%) compared to premolars (14.9%) (Table 2). The preference for composite in premolars was statistically significant (p=0.002), whereas the difference in molar restorations was even more pronounced (p=0.000), suggesting a clinical trend favoring composite resin for aesthetic restorations in visible areas while amalgam remained an option for high-load-bearing teeth. The majority of restorations involved Class I and Class II cavities, with composite resin being preferred for Class II restorations (35.7%) due to its adhesive properties, while amalgam was more frequently chosen for Class I lesions (50.3%) due to its durability (p=0.015). For more extensive cavities, such as Class III, Class IV, and Class V, composite resin was the predominant material, aligning with its ability to preserve tooth structure and provide aesthetic benefits (Table 3).

Table 1: Distribution of Restorative Materials Used

Restorative Material	Dental Department (n=693)	Public Health Units (n=1664)
Composite Resin (R)	78.28	92.63
Amalgam (AM)	21.72	7.37

Table 2: Restorations by Tooth Type and Material

Tooth Type	Composite Resin (%)	Amalgam (%)
Premolars	85.1	14.9
Molars	74.3	25.7

Table 3: Cavity Class Distribution

Cavity Classification	Composite Resin (%)	Amalgam (%)
Class I	40.2	50.3
Class II	35.7	42.9
Class III	10.1	3.5
Class IV	7.6	2.1
Class V	6.4	1.2

Table 4: Factors Influencing Material Choice

Factor	Composite Resin (%)	Amalgam (%)
Less Technique Sensitivity	0.0	68.6
Aesthetic Preference	100.0	0.0
Durability	5.0	67.5
Tissue Preservation	85.7	0.0
Patient Choice	65.7	25.7

Among dentists, the preference for composite resin was primarily driven by aesthetics (100%), dental tissue preservation (85.7%), and patient preference (65.7%). In contrast, amalgam was favored for its ease of handling (68.6%) and durability (67.5%) ($p<0.05$ for all factors) (Table 4). These findings highlight a divergence between patient expectations and clinical decision-making, where aesthetics plays a critical role in composite selection, whereas durability and technique simplicity influence amalgam use.

The study findings underscore a shift towards composite resin as the preferred restorative material, particularly in academic and private settings, where patient-driven factors such as aesthetics and minimally invasive techniques are prioritized. However, amalgam remains relevant in public health dentistry due to its longevity and operator efficiency. Unexpectedly, a substantial proportion of composite restorations were applied to high-stress occlusal surfaces, raising concerns about their long-term durability. These results suggest the need for further longitudinal studies to assess the survival rate and failure patterns of posterior resin restorations compared to amalgam.

DISCUSSION

The findings of this study highlight a clear transition in restorative material preference, with composite resin emerging as the predominant choice in the academic and private practice settings, while amalgam remains prevalent in public health dentistry. This shift aligns with global trends emphasizing aesthetic-driven treatment choices and minimally invasive restorative approaches (1). However, the continued use of amalgam in public health settings reflects its well-established advantages in durability, cost-effectiveness, and resistance to technique sensitivity, particularly in high-load-bearing posterior teeth (2). The significant difference in material selection between the two settings underscores the influence of economic factors, clinical training, and patient expectations in determining restorative choices.

Comparing our findings with previous literature, similar studies have demonstrated a global decline in the use of dental amalgam, with composite resin increasingly favored for posterior restorations. In a study conducted in European dental schools, 85% of institutions reported a marked reduction in amalgam usage, citing regulatory restrictions and patient demand for esthetic alternatives as primary drivers (3). Conversely, long-term clinical evaluations have repeatedly shown that amalgam restorations outperform composite in posterior load-bearing areas, with lower rates of secondary caries and fracture (4). Our results confirm this trend, as dentists in the public health sector continued to rely on amalgam for its longevity and ease of placement, despite composite being the preferred material in educational institutions.

The preference for composite in premolars and esthetically significant areas aligns with its adhesive properties and capacity for conservative tooth preparation. This finding is consistent with studies demonstrating that adhesive restorations preserve more tooth structure compared to amalgam, which requires macro-mechanical retention (5). However, our data revealed that a substantial proportion of composite restorations were performed on molars, raising concerns regarding their long-term clinical survival under occlusal stress. Several clinical trials have shown that composite restorations exhibit higher failure rates in molars due to polymerization shrinkage, wear, and marginal degradation, which can contribute to recurrent caries and restoration failure (6,7). While newer bulk-fill composites and improved bonding systems have enhanced the mechanical properties of resin restorations, long-term clinical outcomes remain an area of ongoing investigation.

The study also revealed that material selection is influenced by both operator and patient-driven factors. Dentists favored amalgam for its ease of handling and reduced technique sensitivity, whereas composite was primarily chosen for its aesthetic advantages and patient preference. These findings are supported by previous research indicating that composite restorations require meticulous placement techniques, moisture control, and incremental layering to ensure optimal longevity, factors that may limit their widespread use in high-volume public health settings (8). The divergence in training experiences among dental students further highlights the evolving educational landscape, where some institutions have completely phased out amalgam instruction, while others continue to teach it as a necessary skill for clinical practice (9).

Despite the valuable insights gained, this study has several limitations. The cross-sectional design precludes the assessment of long-term restoration survival, and the reliance on patient records and self-reported questionnaires introduces the possibility of recall and reporting bias. Additionally, the sample size, although substantial, may not fully represent broader clinical practice variations, particularly in different geographic regions with varying regulatory policies on amalgam use. Furthermore, the study did not control for operator experience or patient-specific factors such as oral hygiene, occlusal forces, or caries risk, all of which could influence restoration longevity. Future research should focus on longitudinal studies evaluating the survival rates and failure modes of composite versus amalgam restorations in posterior teeth. Randomized controlled trials with standardized follow-up periods would provide more definitive evidence on the clinical performance of both materials. Additionally, research exploring the cost-effectiveness of composite in public health settings is warranted, as the initial higher cost and technique sensitivity may pose barriers to widespread adoption. Investigations into alternative restorative materials, such as bioactive composites and high-strength glass ionomers, could also provide insights into the next generation of posterior restorative options.

CONCLUSION

In conclusion, while composite resin has become the dominant choice for posterior restorations in academic and private settings, amalgam remains relevant in public health dentistry due to its superior durability and cost efficiency. The findings emphasize the need for evidence-based material selection that balances aesthetic demands with functional longevity. Given the increasing regulatory and patient-driven shift away from amalgam, ongoing advancements in composite materials and adhesive technology will play a crucial role in determining the future of posterior restorations in clinical practice.

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